Participation, Spectatorship and Media Coverage in Sport

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Participation, Spectatorship and Media Coverage in Sport[1]

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Abstract

This article considers the relationship between active participation in sport, sports spectatorship and television viewing habits using data from the 2005 DCMS Taking Part Survey. We find robust evidence that participation and sports spectatorship are symbiotically linked. In contrast, increase TV viewing per se leads to a reduction in participation.

Key Words: Sporting participation, spectator demand, count models

JEL Codes: C2, D12

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1. Introduction

Current sports policy in the UK emphasises a symbiotic link between the hosting of major sports events and participation in sport. The symbolism of such a link is readily emphasised in the London 2012 promotional material in which a young black child visualises their participation in sport because aspirations are raised by viewing the Olympic Games. The rational argument lying under such an image is that major events have positive externalities that galvanise latent demands for sport, and which can subsequently become exercised through the use of physical infrastructure developed as part of the hosting of the event as legacies (DCMS/Strategy Unit, 2002). The main point is that viewing sports events live or via the media is the key to revealing latent demands.

What is significant, however, is that the links between sports participation, and sports spectatorship, both live and in the media have simply not been analysed in the literature with the implication that such claims lack an evidence base. Whilst there is now a well established sports economic literature, its typical focus is upon aspects of professional team sports such as competitive balance, the labour market in sports, attendance and media demand, as well as the economic impact of sports infrastructure and events. Likewise, a growing literature examining participation in sports does not examine the links between the various demands such as active participation in sport as a consumer-producer; spectating at live sports events and, finally, watching sports through the medium of TV. Using an econometric model, this paper explores official data in the UK and finds robust evidence that sports participation and sports spectatorship are symbiotically linked.

The paper proceeds as follows, Section 2 reviews the policy context of the current research. Section 3 review the literature on sports participation, spectating at events live and through the media. Section 4 discusses the data and variables used in the current study. Section 5 provides details on the econometric methods employed and the results and discussion are presented in Section 6. Conclusions then follow.

2. Policy Context

As detailed in Gratton and Taylor (2000) and Downward *et al* (2009) the sports economy comprises a series of interconnected sectors that embraces professional team sports, sports events and mass participation. In the former two contexts sport is consumed by spectators either in a live setting or live or recorded via the media. As is well documented in the professional team sport literature (Borland and Macdonald, 2003, Downward *et al* 2009) consumption is of a contest jointly produced by the competitors. This, of course, also applies to events. The essential difference between sports events and professional team sports, therefore, is that the latter is organised by teams in cartel leagues with regular series of fixtures, whereas the former is a more irregular sporting encounter, of a more limited duration than a season, and can embrace more than one sport. Both sports leagues and sports events can operate at both the elite and non-elite levels.[2]

As Gratton and Taylor (2000) note, sports events can be classified according to different criteria, such as their regularity and their significance in both sporting terms and the level of economic activity that they generate. For example most sports have some form of annual national championships and most, but particularly younger-age championships, have relatively little economic activity associated with them as the spectators are primarily connected to the sports participants. The participants moreover are more likely to be amateur and not necessarily elite. In contrast, events such as Formula 1 Grand Prix, Wimbledon tennis, Six Nations Rugby internationals generate much more economic activity as they are major spectator events involving elite professional athletes. Likewise, whereas some multisport events have sporting but little economic significance, such as IAAF meets, events such as the Olympic and

[2] The development and origin of professional sports and their tournaments is discussed further in Downward *et al* (2009). Suffice it is to note in the current context that in the UK the now traditional knockout cup competitions were typically the original basis of competition but as the sports developed and embraced professionalism leagues, that is round-robin tournaments, developed. These have now further evolved to accommodate multi-stage tournaments such as playoffs and international competition such as the Champions League and Heineken Cup.

Commonwealth Games have much greater economic activity associated with them.[3] Clearly this also applies to events such as the World cup in various sports.

The remaining sector of the sports economy comprises mass participation activity. Broadly speaking, from an economic perspective this involves the consumption of sport as participation by consumer-producers who allocate time and market goods to the pursuit of the relevant activity (Downward *et al* 2009). Nonetheless, external (to the producer) supply opportunities vary for the consumer. They can involve completely informal activity by individuals and self-chosen groups being undertaken in public spaces such as parks or the neighbourhood or in their own private spaces, such as gardens. Activity can also take place in leisure facilities provided by the public or private-sector in which the participant acts as a customer.[4] Finally, and common to most countries, participation can occur through formalised sports-club systems that are the origins of many professional sports organisations, and which restrict access according to some form of membership criteria (Downward *et al* 2009).

These sectors have evolved and remain connected in a complex way though are of significance for both governing bodies and current UK Sports policy.

In general for example a key historic emphasis of sports policy has been to address welfare issues as well as to promote the development of talent to participate in elite sport. In this respect an overarching concept lying behind sports policy has been the Sports Development Continuum (Hylton and Bramham (2008). This maintains that if more people can be attracted to sport as beginners, or children learning the foundation

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[3] A careful distinction is drawn between the levels of economic activity and significance of the events and their impact. It is only in the latter case that the net-benefits of sports events are identified. The evidence is that these impacts are likely to be weak (see Baade, 2007).

[4] It should be noted that the distinction between public and private sector activity is blurred in the UK. Some private sector businesses have been harnessed to underwrite public sector policy projects in conjunction with governing bodies. For example McDonald's sponsors community football activities for the FA, whilst David Lloyd Leisure hosts Lawn Tennis Association activities etc. Moreover, previously public sector leisure centres are now run by franchised private sector organisations since Compulsory Competitive Tendering and Best Value were introduced to the provision of public sector services in the 1980s and 1990s respectively.

skills for sport, then regular sports participation will occur. This will promote desires to enhance skills and performance through regular training which may then, ultimately, result in higher levels of performance in competition generally, but also at the elite level. This developmental model postulates a supply chain through which casual mass participation may become more formalised, competitive and feed into elite activity and underpin, for example, Long Term Athlete Development planning (Downward, forthcoming). The emphasis on elements of this continuum have altered over time, however, and sports development has also been linked to harnessing positive externalities for health and welfare purposes.

For example the first major sports policy development in the UK was the Wolfenden Committee report of 1960 "Sport and the Community", in which a recommendation for the establishment of a Sports Development Council was made, as well as a public recognition of the lack of sports facilities. The Advisory Sports Council was established in 1965 and their role was to advise the government on co-operation between statutory bodies and the pre-existing largely voluntary sports sector. In 1966 the Council embraced the Council of Europe's "Sport for all" policy as one of its aims, as well as working towards the development of elite athletes. This advisory role supporting links to a primarily voluntary system of administration and sports delivery changed with the formation of the executive Sports Council in 1971 by Royal Charter. Significantly this organisation identified sport as an integral part of social policy and enhancing social welfare. These developments in the UK were informed again by the broader policy direction in Europe. In 1975 the Council of Europe published the European Sport for All Charter which, in Article 1, argued that 'Every individual shall have the right to participate in sport.' The right to Sport for All was now justified in terms of 'sport being an important factor in human development' and an 'aspect of socio-cultural development' which is related to a wide range of welfare services including education, health, social services, land use planning, and the arts. As Henry (2001) argues, this resonated with the 'welfare-reformist' principles of the then current UK government. Large scale investment in facilities, particularly swimming pools then occurred (Gratton and Taylor, 1991).

Subsequent policy emphasis, following the publication of three white papers; "Sport and Recreation" (1975), "Policy for inner cities" (1977) and "Recreation and

Deprivation in Urban Areas" (1997), led to a target upon non-participants and the need to use sport to enhance social welfare. Similar sentiments were expressed in policy discussion which led to the publication of "Sport in the Community: The Next Ten Years" (1982) and "Sport in the Community: Into the 1990s" (1988). In these documents the policy impetus changed from the provision to the *use* of facilities to enhance welfare.

This change of emphasis reflected the broad policy sweep towards deregulation and a focus upon the individual making appropriate choices for their welfare. This process began with the conservative governments of Margaret Thatcher and John Major and the coincident general policy emphasis upon cutting public expenditures.
This policy agenda had an impact on sports supply under an extension to the Local Government Act (1988), when, in 1989, complusory competitive tendering (CCT) was advocated for local authority services. This meant that the provision of sports and leisure services could only be retained by the public authorities if they had competed for the right to provide such services with other private sector companies. CCT was, however, replaced when the Local Government Act (1999) placed a duty on local authorities to provide Best Value (BV) services instead. The impetus of this policy came from the first New-Labour government and reflected in the White Paper 'Modernising Government' (1999).

One other consequence of the need to increase accountability in public expenditure in sport became evident in an increasing policy upon the promotion of elite sport success. Consequently the Sports Council was abolished in 1996 and replaced by UK Sport. This body had a specific remit to allocate funds from the National Lottery to achieve Olympic Success. Sport England was then established as a UK-regional council along with other regional sports councils to focus upon sport more generally, including mass participation. (See Green, 2004).

A further consequence of these supply-side changes in policy was the development of a burgeoning private sector in sports participation including the development of health and fitness chains. For example Fitness First began as a single health and fitness club in Bournemouth in 1993. Likewise, Esporta in 1994, with the purchase of the Royal County of Berkshire Health and Racquets Club. Both have grown to be

large-scale health centre chains, alongside others. These cater for a wide range of health and fitness interests, including swimming and racquet sports, and in the latter case work as centres of excellence with governing bodies (Mintel, 2007). Over the same period the informal sector has also been characterised by innovative change. For example, 'five-a-side football' as well as being played in an entirely self-organised manner, has also been increasingly supplied by companies such as the Powerleague Group PLC, which was established in December 1999.

Current Sports Policy and Provision in the UK underwent a significant overhaul following the publication of "Game Plan, a strategy for delivering Government's sport and physical activity objectives" in 2002 (DCMS/Strategy Unit, 2002). This document identified the two main and alleged symbiotic objectives for government sport policy discussed in the introduction (p12), and which have recently been reaffirmed in "Playing to win: A new era for sport" (DCMS, 2008) . They include increasing participation in sport and physical activity, primarily because of the significant health benefits and to reduce the growing costs of inactivity, and also to achieve a sustainable improvement in success in international competition, particularly in the sports which matter most to the public, primarily because of the 'feelgood factor' associated with winning. Naturally such policy sentiments underpinned the London 2012 bid and the desire for the UK to host other events.

To deliver these 'twin-track' outcomes, and following criticism of the policy delivery structure in the Carter (2005) report, UK Sport now has sole responsibility for elite sport, the Youth Sport Trust for school and young people's sport (under the age of 16 years old) and it was initially the intention that mass sports participation generally was targeted through the regional sports councils working, in England, with County Sports Partnerships (CSP). These partnerships were developed to coordinate National Governing Body and Local Authority inputs to sport in a set of local Community Sports Networks (CSN) in which local provision of sport by the education, private, public and voluntary sports-club sectors were drawn together. In the other countries of the UK the separate sports councils retained responsibility for sport. (DCMS, 2008).

Further refinement has, however, taken place. In particular, since 2008, Sport England now takes full responsibility for 'community' sport (Sport England, 2008).

Moreover, the focus for the development of this sport has shifted from broader social and welfare emphases towards the needs of sport. Sport England's current key policy objectives are: developing talent that can progress to elite level (Excel), encouraging participation across the community (Grow) and to enhance the satisfaction of participants of their experiences generally whilst reducing the post-16 year old drop out rates in sport (Sustain).

Despite these policy initiatives and changes, however, there has been little critical reflection on the likely feedback between sports participation and event spectatorship (of any type and either live or on TV). However, it is highly likely that many of the consumer-producers of mass participation sport are also consumers of sport at live events, and or by the media. Significantly, too, the opportunities and demands for spectatorship have been rising, particularly with professional sport. For example, the growth of Satellite Broadcasting has both underpinned the repackaging of many sports leagues leading to rising attendances, as well as raising the opportunities to view live sport albeit by subscription (Downward *et al* , 2009).

It is these developments which naturally raise the important question of whether or not participation is affected by media and live viewing of sport. Naturally Governing Bodies need to understand the impact that this might have on their sports development and, as already noted current government policy assumes that hosting major sports events and developing a fit and active nation through sports participation are symbiotically linked (DCMS/Strategy Unit, 2002). Significantly, there is no substantive research that addresses these issues. The following literature review exemplifies this situation.

3. Literature review

The literature on sports demands can be distinguished as belonging to three main, and discrete foci; the attendance demand for professional sports, participation demand and spectatorship at major sports events. The attendance demand for professional sports leagues is extremely well researched and summarised in Borland and MacDonald (2003) and Downward *et al* (2009). The main findings of the literature include that demand is generally found to be price, and to a lesser extent income, inelastic. The

market size of teams is ubiquitously significant as are measures of team quality, the success of teams, favourable weather, local rivalries, matches that have sporting significance; such as local derbies, and the rescheduling of games away from traditional times and days, for example as broadcasting income has reshaped traditional competitions. There is some growing evidence that uncertainty of outcome stimulates demand, but the results are mixed as are those for the effects of habit persistence on attendance.

Of particular significance for this paper is the impact of broadcast media on attendance demand, and also the broadcasting demand for sport. In the former case the historical literature indicates some mixed results, however, more recent literature has shown that once the rescheduling of matches that often occurs with TV broadcasts is controlled for, there is some evidence of a substitution effect on attendances. However, it is also argued that whilst televised games reduce attendances, overall the televised games are correspondent with increased revenues for the clubs in the Premier League and First Division (See Baimbridge et al 1996, Forrest et al 2004). In the second instance, as far as the media demand for sport is concerned, research in economics is scant, though two innovative studies, Forrest et al (2005) and Alavy et al (2006) examine the choice of broadcasters to televise a game and broadcast viewing figures on a minute-by-minute basis respectively. In the former case it is shown, that in the second-half of the season in which broadcasters have more discretion over the games that are televised, uncertainty of outcome increases the likelihood of a game being shown live. In the latter case it is shown that viewers prefer eventful contests with a result rather than uncertain outcomes and 'tame draws'. In general, however, this literature does not examine this demand in connection with spectatorship at live matches, or participation in sport. One important exception is Buraimo (2008) who examines the joint demand of English Football League match day and broadcasting attendances. It is concluded that whilst broadcasting matches reduces match day attendance, there is positive feedback, such that larger attendances have positive impacts on broadcasting audiences.[5]

[5] These are interesting findings, but one potential problem with these results, which are derived from two separate regressions controlling for the impact of each alternative viewing option, is that other intervening factors could influence the broadcasting demand equation, such as the attractiveness of the

There is now a growing international literature examining sports participation (Downward and Rasciute, forthcoming; Wicker, Breuer and Pawlowski, 2009; Downward and Riordan, 2007; Humphreys and Ruseski, 2006; Taks and Scheerder, 2006; Lera-López and Rapún-Gárate, 2005; Stratton *et al* 2005). The general findings of the literature are that males tend to participate more in sport than females, except in particular aesthetic activities as well as games that developed as female sports. Lower age, higher incomes and higher socio-economic status also raise the participation rate in sports. The same is true of health being self-reported as better for respondents, and levels of education being higher. A variety of household characteristics also appear to reduce participation in sport. These include being married or a couple and, particularly the presence of children in the household. However, participation in other sports activities, or having active family members does promote sports participation. Finally, there is evidence that increased work hours can reduce participation rates as can being of a non-white ethnicity. Whilst it is recognised that there are possible substitute relationships in sports participation, the relatively sparse literature examines other leisure activities and not live and media sports spectatorship (Downward and Rasciute, forthcoming; Kesenne, 1981, 1983; Kesenne and Butzen, 1987).

Finally, the literature on attendance demand at live sports events, as distinct from sports leagues, is relatively undeveloped. Most of the literature on sports events is connected with economic impacts and, consequently, refining which elements of spectator demand (and expenditures) should legitimately be measured (Crompton, 1995, 2006; Preuss, 2004). The literature which examines behaviour has tended to develop out of sports tourism research and, particularly, is concerned with exploring the motivations to attend events, (for example see; Campbell, Aiken and Kent 2004; Clowes and Tapp 2003; Crawford 2003; Funk and James 2001; Giuliannotti 1995; Hunt, Bristol and Bashaw 1999;; Mahony, Madrigal and Howard 2000; Stewart, Smith and Nicholson 2003; Trail, Anderson and Fink 2000 ; Trail Fink and Anderson 2003) as well as taxonomies of sports tourist (Glyptis, 1982; Weed and Bull, 2004) and distinguishing between active participants and passive spectators (Weed and Bull,

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fixture. In other words only aggregate results can be generated. In this research data on the same individuals can be examined.

2004). However, none of this work has explored the relationships *between* sports demands either. Consequently, it is to address these gaps in the literature that this paper develops a model of sports participation that explicitly accounts for both spectating at live sports events as well as the TV coverage of sports (and TV watching generally).

4. Data and Variables

To model the relationships between sports participation, spectating at sports live at events and watching sports on TV data from the first tranche of the DCMS Taking Part Survey from 2005, and now lodged in the Data Archive for public access, is analysed. This was a three-year survey that has recently been completed in 2008 and collected data on participation in culture, leisure and sport in England for adults aged 16 years and over[6]. The first tranche of data comprised 28,117 respondents. Data was collected by individual interview concerning participation or not over the last four weeks prior to the interview, the last 12 months, the number of times that the sport was participated in over the four week period and the average number of minutes that each sport was practiced for 67 sports. Summary statistics on proportions participating, average length of participation (in minutes) and average number of days of participation (over the last four weeks) for the more popular sports and physical activities as well as those for the most well known team sports is presented in Table 1.

Swimming is the most popular activity, with around 22% of the sample participating during the four weeks prior to interview. The second most popular activity is health, fitness, gym or conditioning activities followed by cycling. Health, fitness etc and cycling are also prominent in the number of times (in days) of participation, as are weight training and keepfit, aerobics, dance exercise. Unsurprisingly, golf and cricket have the highest levels of average duration: 3 hours and 15 minutes and 2 hours and 36 minutes respectively. With the exception of football participation levels in team

[6] At the time of writing, the second and third years of the survey are yet to be made publically available.

sports is low: less than 1% of the sample participated in rugby and only 1.5% of the sample played cricket[7].

Table 1 [about here]

Data on spectator demand and TV viewing habits are constructed at the aggregate level (i.e. data was not collected on specific sports attended or the specific sports watched on TV). In this regard key covariates are a binary variable measuring if the respondent has attended a live sports event in the last our weeks as a spectator or not; and two binary variables measuring if the respondent watches live sport on TV or not, or other sport on TV or not. As well as sport TV viewing, higher levels of general TV viewing are also included in the analysis as TV viewing comprises the largest passive leisure activity and is, of course, a substitute activity for sports viewing. Higher levels of TV viewing are measured by a series of binary variables. associated with lower levels of participation.

Table 2 reports mean participation rates by minutes, hours and days for all sports for general TV viewing, sports viewing on TV and also attendance at a sports event. The data show that those who watch five or more hours of TV a day participate nearly 50% less than those respondents who watch TV for less than 1 hour per day. However, the effect of watching sport on TV is positively associated with participation. These unconditional figures suggest the impact is greater for non-live, as opposed to live, events. Spectating at live sporting events also appears to have complementary effects on participation. The sample size for the Table is set at 12,370 cases, which is less that the total size. This is because it reflects the maximum sample size available without missing cases across the broad set of covariates used in the analysis. As well as the covariates just discussed, in the empirical analysis that

Table 2 [about here]

[7] These figures are comparable to participation rates found in other surveys, such as the General Household Survey (GHS).

follows we include a variety of covariates which capture socio-economic and demographic characteristics associated with participation in sport. These include the usual variables associated with age, income, gender, marital status and household dynamics (number and composition of people in the household). Table 3 provides a full list of the covariates used in this paper together with their sample mean and standard deviation.

Table 3 [about here]

5. Econometric Methodology

To model the participation decision previous studies have concentrated on some form of binary choice models. Typically a logit-type estimation approach is carried out in order to ascertain the probability (or odds) of participating in sport or physical activity. Often this modelling has formed part of an analysis of frequency of participation using some form of sample selection model, typically a Heckman Model (Heckman, 1979). In fact a number of alternative sample selection models could be employed in this respect. Tobit models are the most traditional possibility but restrict the signs and covariates on the selection and frequency variables, and also rely heavily on the normality of residuals. In this regard the literature's use of a Heckman model is more flexible in that the signs and covariates in the two-part modelling are not restricted to be the same. However, as pointed out by Downward and Riordan (2007), one major disadvantage of the Heckman approach is that in cross-section data, and reduced form estimation, finding variables that are excluded from the frequency equation but not the probability of participation equation, as an indentifying restriction is difficult and, in fact arbitrary in many official data sets. To some extent the same problems would be present with Hurdle models (Mullahy, 1986).

In contrast, the econometric strategy employed in this model is to use count data models. In part this reflects the desire to estimate a single reduced form equation without the employment of arbitrary identification. However, this also reflects the fact that the data on participation in this study is more comprehensive; not only do we know whether the individual participated in a particular sport or physical activity, we also have information on the frequency of participation in days, hours or minutes.

Frequency of participation aggregated across all sports by minute, hour and number of days are displayed in Figures 1, 2 and 3, respectively[8].

Figures 1, 2 and 3 [about here]

The figures clearly display a left-skewed distribution with a high fraction of zero outcomes. As such traditional modelling approaches such as OLS are likely to lead to biased estimates. Further converting the data into a discrete form is not desirable since this will invariably lead to a loss of information. Despite the broadly continuous nature of some of the alternative dependent variables (i.e. minutes and hours) the most appropriate methods of dealing with such a distribution can be argued to be count models. Wooldridge (2002), for example, has argued that count models can be applied to non-negative continuous variables and negates the use of log transformation (e.g. log (1 + y)) which leads to problems in calculating the expected value of y.

The simplest count model is based on the Poisson distribution:

$$p(y_i) = \frac{\lambda_i^{y_i} e^{-\lambda_i}}{y_i!} \tag{1}$$

Where y_i refers to the frequency of participation (days, hours or minutes) in sport or physical activity. λ is linked to an exponential function of the set of covariates:

$$\lambda_i = e^{\beta' x_i + \delta' z} \tag{2}$$

Where x_i is the 1 x k row vector of covariates with corresponding parameter vector β.

[8] In the initial stages of the data analysis it became apparent that for a small number of observations the number minutes, hours and days of participation exceeded the maximum possible. In the case of number of minutes, for example, one individual's total exceeded 40,320, which is based on participation in sport for 24 hours a day for the four week period. Limiting the maximum to the more realistic case of 8 hours or 12 hours per day leads to a reduction of 29 and 14 observations respectively.

One important limitation of the standard Poisson model is the assumption of equidispersion, which states the conditional mean of the dependent variable is equal to its conditional variance. In many applications it is often the case that the conditional variance exceeds the conditional mean, which means the dependent variable is over-dispersed. In order to correct for over-dispersion, a popular alternative is the negative binomial regression (NBR) model. It is obtained as a mixture density (Greene, 2008; Cameron and Trivedi, 2005):

$$p(y_i) = \frac{\Gamma(\theta_i + y_i)}{\Gamma(y_i + 1)\Gamma(\theta_i)} \left(\frac{\lambda_i}{\lambda_i + \theta_i} \right)^{y_i} \left(\frac{\theta_i}{\lambda_i + \theta_i} \right)^{\theta_i} \tag{3}$$

Where Γ is the gamma function and λ_i is linked to the same set of covariates as identified in (2). θ_i is a parameter that determines the degree of dispersion. For the purpose of identification it is assumed to be the same for all individuals. A common formulation is to assume: $\theta_i = \alpha^{-1}$. In this case the conditional mean is $\mathrm{E}(y_i) = \lambda_i$ and the conditional variance is $Var(y_i) = \lambda_i \left(1 + \frac{1}{\alpha^{-1}} \lambda_i \right)$. A statistical test on α determines the appropriateness of the NBR model over the Poisson model, and hence whether there is over (or under) dispersion in the dependent variable.

A specific problem in both Poisson and NBR models occurs when the dependent variable has an overabundance of zeros. Generally this leads to both the Poisson and NBR under-predicting the number of zeros. One solution to this problem is to employ a zero-inflated model. A zero-inflated model considers the existence of two latent groups within the population: one group has zero counts and the other group has strictly positive counts. Consequently estimation proceeds in two parts. In the case of the Poisson, we have:

$$p(y_i = 0) = \eta_i + (1 - \eta_i) e^{-\lambda_i} \tag{4a}$$

$$p(y_i > 0) = (1-\eta_i)\frac{\lambda_i^{y_i} e^{-\lambda_i}}{y_i!} \tag{4b}$$

And for the NBR:

$$p(y_i = 0) = \eta_i + (1-\eta_i)\left(\frac{\theta_i}{\lambda_i + \theta_i}\right)^{\theta_i} \tag{5a}$$

$$p(y_i > 0) = (1-\eta_i)\frac{\Gamma(\theta_i + y_i)}{\Gamma(y_i + 1)\Gamma(\theta_i)}\left(\frac{\lambda_i}{\lambda_i + \theta_i}\right)^{y_i}\left(\frac{\theta_i}{\lambda_i + \theta_i}\right)^{\theta_i} \tag{5b}$$

Where, as before, λ_i is linked to an exponential function of the set of covariates.

This discussion leads to the third reason for employing count data models in the current context. The idea that the zeros are generated from more than one source is particularly appealing in the case of participation in sport and the use of Official data sets. It is possible that a zero could have arisen either because the respondent did not participate in the four weeks prior to interview (but had done so in a previous period) or the respondent had never participated. In the case of individual sports, a third possibility arises: the respondent did not participate in the particular sport being asked about but did participate in another sport. In order to establish statistically the appropriateness of a zero-inflated model the non-nested test suggested by Vuong (1989) can be used.

6. Results[9]

To begin with we estimate overall levels of participation aggregated across all sports using standard OLS. Model 1 in Table 4 presents the results of the frequency of

[9] The reduced sample size refers to the 'core' of observations across the covariates in which missing values were deleted to facilitate comparison of models. Where necessary weights were attached to the estimators to control for the sampling biases in the dataset.

participation in minutes with robust standard errors. Many of the parameters on the variables are in line with previous studies. In particular, participation declines with age, number of children, those who are working and those who are married. Males, on average, participate 341 minutes more than females. The results relating to TV viewing habits also conform to prior expectations: just one hour of TV viewing per day decreases by participation on average by 108 minutes. This figure rises to 274 minutes for those who watch five or more hours per day.

The variables broadly described as relating to watching sport all have positive and statistically significant effects on participation. Attendance at one or more live sporting event during the previous four weeks has the largest impact, increasing participation, on average, by 171 minutes. The positive effect associated with watching sport (live or otherwise) on TV suggests that whilst TV in general is a substitute for participation sport on TV acts as a complement.

The inclusion of month dummies and weighting the observations (Model 2) generally have the effect of attenuating the results both in terms of the size of coefficients and the level of significance but nonetheless are comparable to Model 1. In Models 3 and 4 minutes of participation are replaced with hours and days of participation, respectively. Whilst Model 3 is essentially a scaled version of Model 2, some differences are observed when the dependent variable is days of participation. For example, in Model 4, and unlike previous models, both education (positive) and smoking (negative) are now statistically significant.

The various count models for hours of participation and days of participation are presented in Tables 5 and 6 respectively[10]. The estimates for the basic Poisson models appear to generate suspiciously small standard errors and therefore very large z-scores. There are only three variables that are not statistically significant at the 5% level or better (in the case of the earlier OLS model, there were around 17 variables deemed to be insignificant).

[10] Given the similarity between hours and minutes we do not include analysis relating to minutes of participation from this point onwards.

Due to the scepticism of the results reported in the Poisson model, and in order to better control for unobserved heterogeneity, the NBR model was estimated. The results are consistent with the OLS results presented in Table 4. Age, number of children and those working remained negatively associated with participation whereas males, number of people in the household and health status are positively associated with participation. TV viewing habits and watching sport also remain important: those who go to watch live sport increase their hours of participation by about 20% (or about 15% more days) than those who do not. Similar magnitudes are found for those respondents who watch live sport on TV.

Because of the presence of an overabundance of zeros, both Poisson and NBR models are likely to under-predict the number of zeros. To overcome this zero-inflated Poisson (ZIP) and zero-inflated negative binomial (ZINB) models were estimated. The zero-inflated models generate two sets of coefficients: one set for the binary model, which establishes respondents having zero levels of participation, and one set for the Poisson or negative binomial parts, which predicts the counts for the respondents with positive levels of participation. In the cases presented in this paper, we use the logit specification for the binary model.

Because the binary model is predicated on establishing the determinants of a zero level of participation, the signs of the coefficients tend to be opposite those in the Poisson and negative binomial parts. Once again, however, our results suggest there are one or two anomalies. For example, the probability of non-participation is higher for those respondents who smoke daily but it also positive on the level of participation (in the case of hours of participation but not days of participation).

According to the results of the ZINB model, and similar to our finding in the NBR model, attendance at live sporting events has a similar effect to watching live sport on TV. Attendance at live sporting events does however exert a greater influence on the probability of participation.

In order to determine which of the various count models is the most appropriate Figures 4 and 5 plot the residuals from the estimated count models. The plots reveal

that the Poisson model under-predicts the number of zeros by a large margin. The NBR model does better but it appears that the zero-inflated models perform best. A number of formal statistics were used to make direct comparisons of the count models (Table 7). The likelihood ratio test of over-dispersion indicates that the NBR is favoured over the Poisson in both the hours and days participation equations. The non-nested Vuong test confirms the appropriateness of zero-inflated models over the Poisson and NBR counterparts. Comparisons between Poisson and ZINB and NBR and ZIP are made using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). Overall, the results suggest the ZINB is the preferred model. and this is consistent with the prior expectations about the data noted earlier.

The above analysis was repeated across a number of individual sports. These are based on the sports listed in Table 1. However, as a further restriction we only include sports that have participation rates of at least 5% because the results become very fragile for smaller sample sizes. Our analysis is also confined to a consideration of hours of participation only.

As noted earlier the theoretical justification for using zero-inflated models is even more appealing in the case of individual sports: as in the combined sport model, a zero count, for example, could be the result of the respondent never participating in sport or not participating during this time-period. A third possibility is that the respondent did not participate in the sport under consideration but did participate in another sport. These theoretical arguments are confirmed by a comparison of count models, which suggest ZINB is again the most appropriate framework. In the interest of space the full results are not presented here but are available from the authors upon request.

The ZINB results across seven individual sports / physical activities are presented in Table 8. The results reveal that with the exception of golf participation tends to decrease with age in the majority of sports. Males are more likely to participate in football, golf and jogging and less likely to be involved in swimming or keepfit. The number of children in the household has a negative effect on participation in golf and keepfit but a positive effect on swimming and football.

The presence of a sports facility close by also appears to be important, particularly for those activities that are venue-based (e.g. keepfit, health and fitness and golf). In the case of swimming, a facility close by is important in terms of whether a respondent participates but turns out to have a negative effect on the frequency of participation.

Finally in relation to spectator demand and TV viewing habits, attendance at live sporting events has the greatest effect on football, jogging and cycling. The more hours of TV watched the greater the probability of non-participation but it appears to have little effect on the frequency of participation. In contrast, and consistent with earlier findings, watching live sport on TV and, to a slightly lesser extent, watching other (non-live) sport on TV is associated with a lower probability of non-participation. This is particularly the case for football, which is perhaps not surprising given its dominance over other sports in the TV schedule.

7. Discussion and Concluding Remarks

As far as the authors can discern, the above results constitute the first analysis of the relationship between the demands for participation sport, and sport watched either live or via the media. The research is important because it provides an opportunity to comment upon current sports policy in the UK which, particularly, in the case of the Olympic Games makes a case that watching live sport or sport on the media might encourage participation and thus consequently contribute to the well-being and health of the nation. Significantly too, governing bodies and community sports policy emanating from Sport England is concerned with promoting sports participation to underpin elite sports development and to contribute to the development of specific sports as a contribution to the health and well-being of the nation.

Naturally the results on many of the covariates are as expected. Being male, younger, unmarried and broadly white British promotes sports participation as does education. The presence of children in the household and lifestyle factors such as smoking reduce participation. Of most significance to this paper, however, is that a broad complementarity is identified between sports participation, and viewing sports either live or via the media as live or recorded activities. Naturally this provides support for

the current emphasis of sports policy in the UK. However, these remarks should be tempered by the general broad finding that increased TV watching hours is linked to reduced participation.

This suggests some potential refinements of emphasis for policy makers. As Downward and Rasciute (forthcoming) find, there is evidence of substitution effects in the UK between sports and leisure activities. The current research suggests likewise for the most common of leisure pursuits. Consequently in as much that promoting further sport on TV adds to total TV viewing, this suggests potential adverse consequences on participation. Clearly the impact of these interactions needs to be unpicked further. One particularly important line of future enquiry should be to try and identify the causality between sport viewing in the media and general TV viewing. However, in as much that attending sports events live is complementary to participation there is the suggestion that participation and sports spectatorship generally are manifestations of a latent variable of 'sport' consumption. In this respect policy may be better targeted at promoting this more general consumer activity than to focus on its constituent parts *per se*.

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Figure 1: Participation in Sport (Total Minutes)

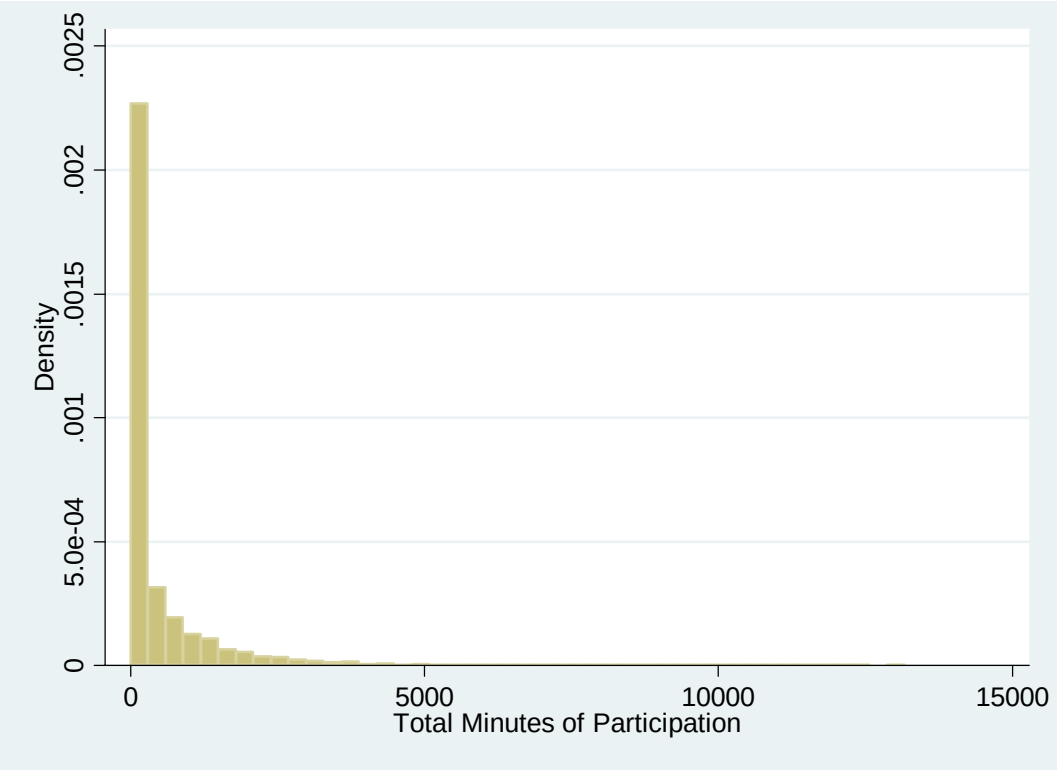

Figure 2: Participation in Sport (Total Hours)

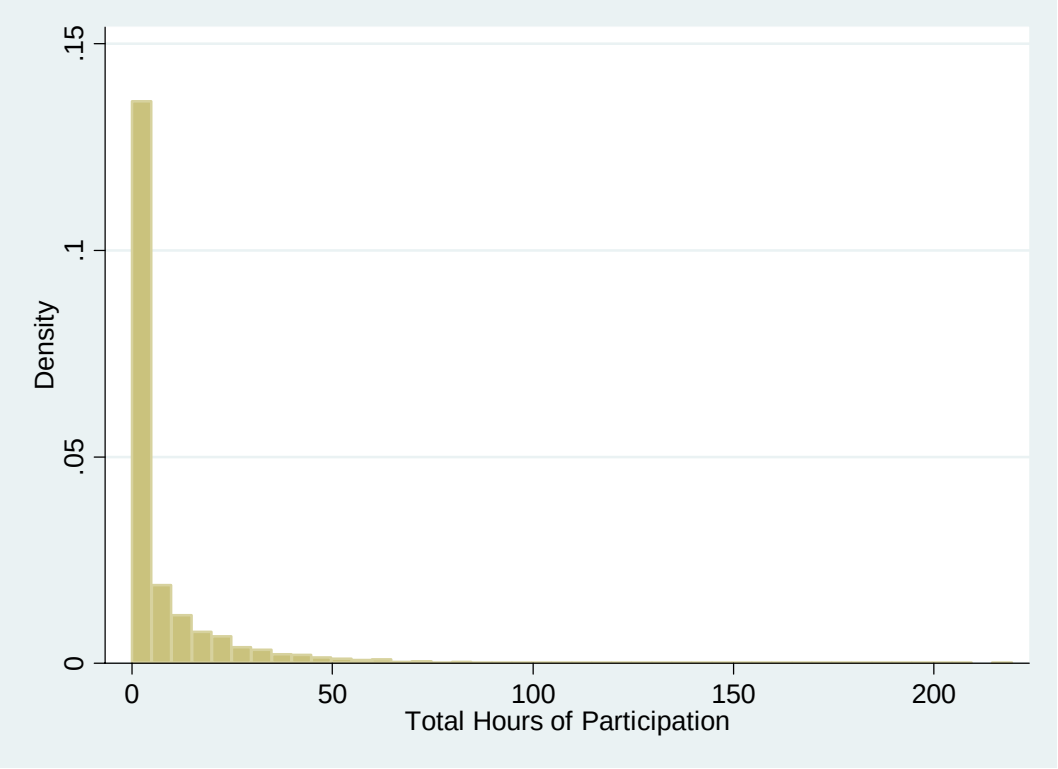

Figure 3: Participation in Sport (Total Days)

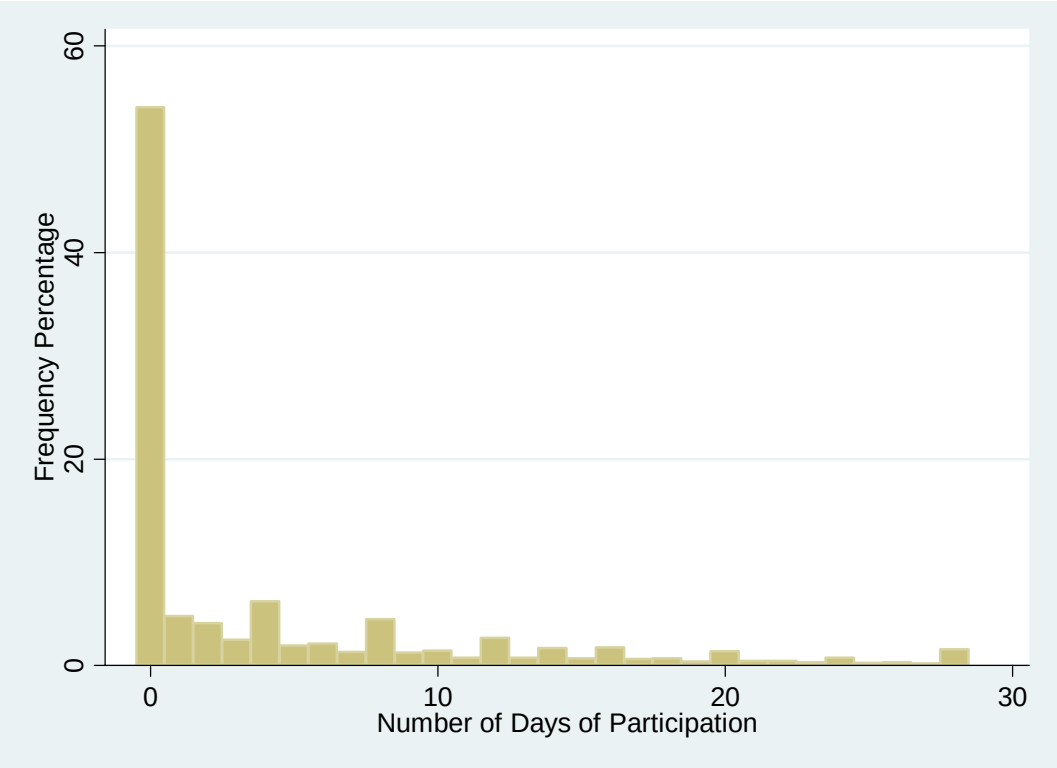

Table 1: Summary Statistics by Sport / Physical Activity

Activity	Observations (%)	Length of time doing activity (minutes)	How often (days)
Swim (indoors)	18.29	56.15	4.26
Swim (outdoors)	3.78	56.68	5.76
Cycling	10.53	38.86	7.94
Health, fitness, gym or conditioning	16.94	67.64	9.29
Keepfit, aerobics, dance exercise	8.62	57.90	8.52
Weight training	3.87	49.31	9.73
Rugby League	0.14	95.29	5.47
Rugby Union	0.68	96.43	5.44
Football (indoors)	3.06	77.21	4.93
Football (outdoors)	6.66	86.18	5.25
Cricket	1.50	156.53	3.42
Netball	0.44	68.24	4.17
Tennis	2.76	84.44	3.77
Badminton	3.33	74.33	3.45
Jogging, cross-country or road-racing	6.43	44.83	7.71
Golf, pitch and putt, putting	5.92	195.33	4.45
Any sport or recreational activity	61.14		

Notes: In Column 2, N = 12,370. Columns 3 and 4 is restricted to participants of the stated activity only.

Table 2: Mean Participation Rates by TV Viewing Habits and Spectator Demand

Characteristic	Minutes	Hours	Days
TV Viewing Habits			
TV less than 1 hour	769.35	12.82	10.46
TV 1 hour	659.84	11.00	8.71
TV 2 hours	589.73	9.83	7.84
TV 3 hours	577.37	9.62	7.20
TV 4 hours	516.78	8.61	6.20
TV 5 or more hours	401.90	6.70	4.90
TV live sport	727.34	12.12	8.73
TV any sport	798.71	13.31	9.25
Spectator Demand			
Attended a live sporting event	873.17	14.55	10.82

N = 12,370

Table 3: Variable labels, Definitions and Summary Statistics

Variable Label	Definition	Mean	Standard Deviation
Socio-Economic and Demographic Characteristics			
SINGLE	1 if respondent has never been married, 0 otherwise	0.324	0.468
MARRIED	1 if respondent is married, 0 otherwise	0.489	0.500
ASIAN	1 if respondent is Asian, 0 otherwise	0.069	0.254
BLACK	1 if respondent is black , 0 otherwise	0.045	0.208
OTHERETH	1 if respondent is from another ethnic minority, 0 otherwise	0.026	0.156
NORTHE	1 if respondent lives in North East	0.092	0.289
NORTHW	1 if respondent lives in North West	0.102	0.303
YORKS	1 if respondent lives in Yorkshire	0.105	0.306
EMID	1 if respondent lives in East Midlands	0.088	0.283
WMID	1 if respondent lives in West Midlands	0.115	0.319
EAST	1 if respondent lives in East England	0.107	0.309
SOUTHE	1 if respondent lives in South East	0.153	0.360
SOUTHW	1 if respondent lives in South West	0.114	0.318
WORKING	1 if respondent is in employment, 0 otherwise	0.668	0.471
STUDENT	1 if respondent is a full-time student , 0 otherwise	0.032	0.175
KEEPHOUSE	1if respondent keeps house, 0 otherwise	0.068	0.251
RETIRED	1 if respondent is retired, 0 otherwise	0.150	0.357
ILLNOTWORK	1 if respondent is ill and cannot work, 0 otherwise	0.030	0.171
HE	Higher education or equivalent = 1, 0 otherwise	0.420	0.494
ALEVEL	1 if respondent has A Levels = 1, 0 otherwise	0.198	0.399
MALE	1 if Male, 0 Female	0.464	0.499
AGE	Age of respondent	43.638	16.230
DRINKDAILY	1 if respondent drinks alcohol every day, 0 otherwise	0.103	0.304
SMKDAILY	1 if respondent smokes every day, 0 otherwise	0.206	0.404
GENHEALTH	Self reported general health; 1 very poor, 5 very good	4.105	0.849
NADULT	Number of adults in household	1.981	0.845
NCHILD	Number of children in household	0.665	1.000
LOGINCOME	Log of personal earnings in the last year before tax and other deductions (mid point)	9.039	2.273
Leisure and TV Viewing Habit Variables			
SPCLOSE	1 if sports facility within 20 minutes	0.943	0.233
VOLUNTARY	1 if respondent has undertaken voluntary work within the last 12 months	0.278	0.448

Table 3 (cont.)

Variable Label	Definition	Mean	Standard Deviation
Sport and TV Viewing Habit Variables (cont.)			
LIVESPORT	1 if respondent has attended a live sporting event in the last 4 weeks (as a spectator)	0.156	0.363
TV1HR	1 if respondent watches TV about 1 hours a day	0.135	0.342
TV2HR	1 if respondent watches TV about 2 hours a day	0.298	0.457
TV3HR	1 if respondent watches TV about 3 hours a day	0.239	0.427
TV4HR	1 if respondent watches TV about 4 hours a day	0.138	0.345
TV5PLUS	1 if respondent watches TV about 5 or more hours a day	0.106	0.308
TVLIVESPORT	1 if respondent watches live sport on TV	0.516	0.500
TVOTHERSPORT	1 if respondent watches other (non-live) sport on TV	0.272	0.445

N = 12,370

Table 4: Frequency of Participation (Aggregated): OLS Estimates

Variable	Model 1 (Minutes)	Model 2 (Minutes)	Model 3 (Hours)	Model 4 (Days)
SINGLE	-45.38 (29.74)	-6.95 (40.01)	-0.12 (0.67)	-0.20 (0.25)
MARRIED	-171.62*** (28.53)	-162.17*** (33.49)	-2.70*** (0.56)	-0.77*** (0.21)
ASIAN	-125.40*** (37.72)	-130.55*** (49.46)	-2.18*** (0.82)	-0.24 (0.31)
BLACK	-83.40 (53.50)	-119.90* (69.60)	-2.00* (-1.16)	-0.74* (0.44)
OTHERETH	-24.20 (72.85)	-83.01 (68.34)	-1.38 (1.14)	-1.20*** (0.44)
NORTHE	-9.14 (43.89)	30.99 (52.18)	0.52 (0.87)	-0.05 (0.33)
NORTHW	23.93 (45.60)	48.46 (40.34)	0.81 (0.67)	-0.25 (0.26)
YORKS	-56.16 (42.08)	-32.64 (42.39)	-0.54 (0.71)	-0.50 (0.27)
EMID	18.89 (47.31)	45.20 (44.92)	0.75 (0.75)	-0.34 (0.29)
WMID	-113.00*** (37.69)	-116.74*** (41.19)	-1.95*** (0.69)	-0.54 (0.26)
EAST	-22.85 (41.31)	-2.69 (40.94)	-0.04 (0.68)	-0.43* (0.26)
SOUTHE	-60.14 (37.51)	-40.55 (35.90)	-0.68 (0.60)	-0.52** (0.23)
SOUTHW	-38.66 (41.58)	-12.03 (41.57)	-0.20 (0.69)	-0.37 (0.26)
WORKING	-124.31** (51.34)	-77.25* (46.40)	-1.29* (0.77)	-0.01 (0.30)
STUDENT	-55.80 (95.13)	-132.76* (68.22)	-2.13* (1.14)	-0.74 (0.44)
KEEPHOUSE	-141.75** (57.39)	-74.94 (62.23)	-1.25 (1.04)	-0.81** (0.39)
RETIRED	115.37* (58.81)	195.98*** (59.72)	3.27*** (1.00)	1.04*** (0.38)
ILLNOTWORK	-102.32 (63.80)	-74.41 (79.40)	-1.24 (1.32)	-0.46 (0.50)
HE	36.36* (21.99)	-10.43 (24.00)	-0.17 (0.40)	0.64*** (0.151)
ALEVEL	32.67 (27.23)	-12.46 (27.56)	-0.21 (0.46)	0.30* (0.17)
MALE	341.38*** (21.63)	376.89*** (22.35)	6.28*** (0.37)	1.03*** (0.14)
AGE	-14.83*** (1.033)	-15.40*** (1.10)	-0.26*** (0.02)	-0.10*** (0.01)

Table 4 (cont.)

Variable	Model 1 (Minutes)	Model 2 (Minutes)	Model 3 (Hours)	Model 4 (Days)
DRINKDAILY	13.76 (31.08)	19.10 (33.94)	0.32 (0.57)	0.29 (0.21)
SMKDAILY	-13.13 (26.51)	26.36 (25.84)	0.44 (0.43)	-0.75*** (0.16)
GENHEALTH	141.20*** (11.56)	157.92*** (13.24)	2.63*** (0.22)	0.85*** (0.08)
NADULT	96.21*** (16.57)	102.99*** (12.00)	1.72*** (0.20)	0.24*** (0.08)
NCHILD	-56.11*** (11.84)	-55.45*** (11.72)	-0.92*** (0.20)	-0.21*** (0.07)
LOGINCOME	-7.28 (5.01)	-9.30* (5.19)	-0.16* (0.09)	-0.05 (0.03)
SPCLOSE	132.71*** (34.95)	167.83*** (27.35)	2.80*** (0.75)	1.20*** (0.28)
VOLUNTARY	156.81*** (23.19)	194.19*** (22.79)	3.24*** (0.38)	1.04*** (0.15)
LIVESPORT	171.50*** (30.56)	176.41*** (27.35)	2.94*** (0.46)	0.86*** (0.18)
TV1HR	-108.47** (48.57)	-71.34* (42.83)	-1.19* (0.71)	-0.24 (0.28)
TV2HR	-157.77*** (44.11)	-151.64*** (38.46)	-2.53*** (0.64)	-0.82*** (0.25)
TV3HR	-174.25*** (45.37)	-152.14*** (40.01)	-2.54*** (0.67)	-1.02*** (0.26)
TV4HR	-209.39*** (48.86)	-208.85*** (44.46)	-3.48*** (0.74)	-1.54*** (0.29)
TV5PLUS	-274.11*** (50.98)	-239.33*** (48.83)	-3.99*** (0.81)	-1.89*** (0.31)
TVLIVESPORT	138.86*** (21.50)	148.48*** (23.80)	2.47*** (0.40)	0.72*** (0.15)
TVOTHERSPORT	116.34*** (26.80)	118.80*** (25.79)	1.98*** (0.43)	0.89*** (0.16)
CONSTANT	468.80*** (112.23)	-127.62 (435.28)	-2.13 (7.25)	5.03* (2.7)
MONTH DUMMIES	NO	YES	YES	YES
WEIGHTS	NO	YES	YES	YES
N	12370	12762	12762	11930

Notes: standard errors in parentheses. */**/***, denote significant at 10%, 5% and 1% level respectively.

Table 5: Hours of Participation (Aggregated): Alternative Count Models

Variable	Poisson	Negative Binomial	Zero-inflated Poisson		Zero-inflated Negative Binomial	
			Logit	Poisson	Logit	Neg Bin
SINGLE	-0.04*** (0.01)	-0.07 (0.07)	0.18*** (0.07)	-0.01 (0.01)	0.25*** (0.09)	-0.0004 (0.05)
MARRIED	-0.18*** (0.01)	-0.09* (0.06)	0.10 (0.06)	-0.16*** (0.01)	0.06 (0.08)	-0.15*** (0.05)
ASIAN	-0.15*** (0.01)	-0.19** (0.08)	0.48*** (0.08)	-0.07*** (0.01)	0.64*** (0.11)	-0.04 (0.06)
BLACK	-0.17*** (0.02)	-0.21* (0.12)	0.49*** (0.10)	-0.002 (0.02)	0.61*** (0.13)	-0.02 (0.08)
OTHERETH	-0.10*** (0.02)	-0.08 (0.12)	0.25* (0.13)	0.06*** (0.02)	0.28 (0.18)	0.06 (0.09)
NORTHE	0.03** (0.01)	0.07 (0.09)	0.10 (0.09)	0.007 (0.01)	0.13 (0.12)	0.01 (0.07)
NORTHW	0.07*** (0.01)	0.05 (0.07)	0.04 (0.09)	0.06*** (0.01)	0.04 (0.12)	0.01 (0.06)
YORKS	-0.04*** (0.01)	-0.10 (0.07)	0.05 (0.09)	-0.06*** (0.01)	0.01 (0.12)	-0.10 (0.06)
EMID	0.06*** (0.01)	-0.02 (0.07)	-0.09 (0.09)	0.002 (0.01)	-0.13 (0.12)	-0.08 (0.07)
WMID	-0.19*** (0.01)	-0.17** (0.07)	0.08 (0.08)	-0.15*** (0.01)	0.07 (0.11)	-0.16** (0.06)
EAST	-0.004 (0.01)	0.01 (0.07)	-0.10 (0.09)	-0.07*** (0.12)	-0.13 (0.12)	-0.07 (0.06)
SOUTHE	-0.07*** (0.01)	-0.09 (0.06)	-0.12 (0.08)	-0.14*** (0.01)	-0.22** (0.11)	-0.18*** (0.06)
SOUTHW	-0.01 (0.01)	0.01 (0.07)	-0.02 (0.09)	-0.06*** (0.01)	-0.03 (0.11)	-0.06 (0.06)
WORKING	-0.09*** (0.01)	-0.13* (0.08)	0.03 (0.09)	-0.16*** (0.01)	-0.04 (0.12)	-0.19*** (0.07)
STUDENT	-0.18*** (0.02)	-0.28** (0.11)	-0.07 (0.16)	-0.16*** (0.02)	-0.21 (0.24)	-0.19* (0.10)
KEEPHOUSE	-0.13*** (0.02)	-0.23** (0.10)	0.38*** (0.12)	-0.10*** (0.02)	0.45*** (0.15)	-0.16* (0.09)
RETIRED	0.25*** (0.02)	0.14 (0.10)	-0.20* (0.11)	0.16*** (0.02)	-0.29* (0.15)	0.11 (0.09)
ILLNOTWORK	-0.42*** (0.03)	-0.58*** (0.14)	0.46*** (0.15)	-0.02 (0.03)	0.45** (0.19)	-0.11 (0.14)
HE	0.02*** (0.007)	0.11*** (0.04)	-0.31*** (0.05)	-0.02*** (0.007)	-0.39*** (0.06)	0.02 (0.04)
ALEVEL	0.02*** (0.007)	0.001 (0.05)	-0.20*** (0.06)	-0.02** (0.008)	-0.24*** (0.07)	-0.01 (0.04)
MALE	0.59*** (0.007)	0.56*** (0.04)	-0.33*** (0.05)	0.46*** (0.007)	-0.22*** (0.06)	0.52*** (0.03)
AGE	-0.02*** (0.0003)	-0.026*** (0.002)	0.045*** (0.002)	-0.009*** (0.0003)	0.06*** (0.003)	-0.008*** (0.002)

Table 5 (cont.)

Variable	Poisson	Negative Binomial	Zero-inflated Poisson		Zero-inflated Negative Binomial	
			Logit	Poisson	Logit	Neg Bin
DRINKDAILY	0.05*** (0.01)	0.06 (0.06)	-0.10 (0.07)	-0.003 (0.01)	-0.12 (0.09)	0.01 (0.05)
SMKDAILY	0.09*** (0.007)	0.07 (0.04)	0.20*** (0.05)	0.09*** (0.008)	0.32*** (0.07)	0.10*** (0.04)
GENHEALTH	0.27*** (0.004)	0.28*** (0.02)	-0.26*** (0.03)	0.18*** (0.004)	-0.27*** (0.03)	0.19*** (0.02)
NADULT	0.11*** (0.003)	0.09*** (0.02)	-0.05* (0.03)	0.09*** (0.003)	-0.04 (0.04)	0.10*** (0.02)
NCHILD	-0.06*** (0.003)	-0.08*** (0.02)	0.01 (0.02)	-0.08*** (0.004)	-0.003(0.03)	-0.08*** (0.02)
LOGINCOME	-0.0015 (0.0014)	-0.02** (0.01)	-0.00001 (0.01)	-0.005*** (0.0015)	-0.002 (0.01)	-0.01 (0.008)
SPCLOSE	0.36*** (0.01)	0.43*** (0.08)	-0.55*** (0.09)	0.09** (0.02)	-0.66*** (0.11)	0.08 (0.08)
VOLUNTARY	0.27*** (0.006)	0.23*** (0.04)	-0.33*** (0.05)	0.15*** (0.006)	-0.36*** (0.06)	0.13*** (0.03)
LIVESPORT	0.20*** (0.007)	0.20*** (0.04)	-0.37*** (0.06)	0.11*** (0.007)	-0.49*** (0.09)	0.12*** (0.04)
TV1HR	-0.07*** (0.01)	-0.13* (0.07)	-0.03 (0.09)	-0.17*** (0.007)	-0.12 (0.12)	-0.20*** (0.06)
TV2HR	-0.21*** (0.01)	-0.23*** (0.06)	0.07 (0.08)	-0.20*** (0.01)	-0.01 (0.11)	-0.25*** (0.06)
TV3HR	-0.20*** (0.01)	-0.21*** (0.07)	0.19** (0.08)	-0.19*** (0.01)	0.16 (0.11)	-0.22*** (0.06)
TV4HR	-0.30*** (0.01)	-0.32*** (0.07)	0.28*** (0.09)	-0.23*** (0.01)	0.22* (0.12)	-0.30*** (0.07)
TV5PLUS	-0.35*** (0.01)	-0.48*** (0.08)	0.53*** (0.10)	-0.26*** (0.01)	0.53*** (0.13)	-0.33*** (0.07)
TVLIVESPORT	0.25*** (0.007)	0.22*** (0.04)	-0.26*** (0.05)	0.14*** (0.007)	-0.29*** (0.06)	0.129*** (0.04)
TVOTHERSPORT	0.14*** (0.007)	0.15*** (0.04)	-0.27*** (0.05)	0.08*** (0.007)	-0.36*** (0.07)	0.05 (0.04)
CONSTANT	0.62*** (0.15)	1.16 (0.73)	-0.20 (0.71)	2.01*** (012)	-0.80 (0.87)	1.93*** (0.58)
MONTH DUMMIES	YES	YES	YES		YES	
WEIGHTS	YES	YES	N/A		N/A	
Log-likelihood	-132677.78	-37208.99	-81013.58		-33670.67	
Pseudo R^2	0.194	0.021				
Number of Iterations	2	4	4		5	
N	12355	12355	12370		12370	

Notes: as Table 4.

Table 6: Days of Participation (Aggregated): Alternative Count Models

Variable	Poisson	Negative Binomial	Zero-inflated Poisson		Zero-inflated Negative Binomial	
			Logit	Poisson	Logit	Neg Bin
SINGLE	-0.06*** (0.02)	-0.10 (0.06)	0.17** (0.07)	-0.01 (0.01)	0.19** (0.08)	-0.02 (0.04)
MARRIED	-0.12*** (0.01)	-0.10* (0.051)	0.08 (0.06)	-0.10*** (0.013)	0.06 (0.07)	-0.12*** (0.04)
ASIAN	-0.028 (0.02)	0.01 (0.08)	0.39*** (0.08)	0.08*** (0.02)	0.46*** (0.09)	0.11** (0.05)
BLACK	-0.12*** (0.03)	-0.11 (0.11)	0.52*** (0.10)	0.11*** (0.02)	0.59*** (0.11)	0.12* (0.062)
OTHERETH	-0.22*** (0.03)	-0.15 (0.11)	0.25* (0.13)	0.01 (0.03)	0.26* (0.15)	-0.01 (0.08)
NORTHE	-0.01 (0.02)	0.01 (0.08)	0.17* (0.09)	0.03 (0.02)	0.20** (0.10)	0.04 (0.05)
NORTHW	-0.04** (0.02)	-0.01 (0.06)	0.07 (0.09)	-0.04** (0.02)	0.08 (0.10)	-0.02 (0.05)
YORKS	-0.09*** (0.02)	-0.09 (0.07)	0.06 (0.09)	-0.04** (0.02)	0.06 (0.10)	-0.04 (0.05)
EMID	-0.053*** (0.018)	-0.06 (0.07)	-0.03 (0.09)	-0.048*** (0.02)	-0.05 (0.10)	-0.06 (0.05)
WMID	-0.10*** (0.016)	-0.09 (0.06)	0.08 (0.08)	-0.04** (0.02)	0.09 (0.09)	-0.05 (0.05)
EAST	-0.07*** (0.016)	-0.06 (0.06)	-0.06 (0.09)	-0.07** (0.02)	-0.08 (0.10)	-0.08 (0.05)
SOUTHE	-0.09*** (0.014)	-0.09 (0.06)	-0.09 (0.08)	-0.10*** (0.02)	-0.13 (0.09)	-0.12*** (0.046)
SOUTHW	-0.06*** (0.02)	-0.04 (0.06)	0.02 (0.09)	-0.06*** (0.02)	-0.02 (0.10)	-0.06 (0.05)
WORKING	-0.006 (0.02)	0.01 (0.07)	-0.03 (0.09)	-0.01 (0.02)	-0.05 (0.11)	-0.02 (0.05)
STUDENT	-0.13*** (0.02)	-0.17 (0.11)	-0.08 (0.16)	-0.13*** (0.03)	-0.14 (0.19)	-0.15* (0.08)
KEEPHOUSE	-0.19*** (0.03)	-0.21** (0.10)	0.31*** (0.12)	-0.06** (0.03)	0.33** (0.13)	-0.08 (0.07)
RETIRED	0.13*** (0.03)	0.15 (0.09)	-0.22* (0.12)	0.12*** (0.03)	-0.25* (0.13)	0.13* (0.07)
ILLNOTWORK	-0.299*** (0.04)	-0.21* (0.13)	0.41*** (0.15)	0.10** (0.04)	0.44*** (0.17)	0.124 (0.11)
HE	0.13*** (0.01)	0.16*** (0.04)	-0.29*** (0.05)	0.04*** (0.01)	-0.31*** (0.05)	0.06** (0.03)
ALEVEL	0.06*** (0.01)	0.06 (0.04)	-0.20*** (0.06)	0.028** (0.012)	-0.22*** (0.06)	0.03 (0.03)
MALE	0.18*** (0.01)	0.15 (0.04)	-0.26*** (0.05)	0.08*** (0.01)	-0.25*** (0.05)	0.08*** (0.03)
AGE	-0.02*** (0.0004)	-0.02*** (0.002)	0.041*** (0.002)	-0.003*** (0.0005)	0.05*** (0.003)	-0.003** (0.0013)

Table 6 (cont.)

Variable	Poisson	Negative Binomial	Zero-inflated Poisson		Zero-inflated Negative Binomial	
			Logit	Poisson	Logit	Neg Bin
DRINKDAILY	0.07*** (0.01)	0.05 (0.05)	-0.08 (0.07)	-0.01 (0.01)	-0.08 (0.08)	-0.002 (0.04)
SMKDAILY	-0.12*** (0.01)	-0.13*** (0.04)	0.21*** (0.05)	-0.08*** (0.01)	0.22*** (0.06)	-0.08** (0.03)
GENHEALTH	0.172*** (0.006)	0.20*** (0.02)	-0.23*** (0.03)	0.09*** (0.01)	-0.24*** (0.03)	0.095*** (0.016)
NADULT	0.030*** (0.005)	0.02 (0.02)	-0.04 (0.03)	0.02*** (0.005)	-0.04 (0.03)	0.025 (0.02)
NCHILD	-0.027*** (0.005)	-0.04** (0.02)	0.01 (0.02)	-0.03*** (0.005)	0.003 (0.03)	-0.03** (0.014)
LOGINCOME	-0.005** (0.002)	-0.014* (0.008)	0.0004 (0.01)	-0.005** (0.002)	-0.001 (0.01)	-0.007 (0.006)
SPCLOSE	0.29*** (0.02)	0.37*** (0.07)	-0.53*** (0.09)	0.05** (0.02)	-0.57*** (0.10)	0.061 (0.06)
VOLUNTARY	0.19*** (0.01)	0.18*** (0.04)	-0.32*** (0.05)	0.05*** (0.009)	-0.34*** (0.05)	0.056* (0.026)
LIVESPORT	0.132*** (0.01)	0.14*** (0.04)	-0.33*** (0.06)	0.05*** (0.01)	-0.37*** (0.07)	0.055** (0.03)
TV1HR	-0.04** (0.02)	-0.08 (0.07)	-0.04 (0.09)	-0.06*** (0.02)	-0.06 (0.10)	-0.07 (0.05)
TV2HR	-0.13*** (0.01)	-0.13** (0.06)	0.06 (0.08)	-0.07*** (0.02)	0.05 (0.09)	-0.077* (0.04)
TV3HR	-0.17*** (0.02)	-0.18*** (0.06)	0.18** (0.08)	-0.07*** (0.02)	0.17* (0.10)	-0.08* (0.05)
TV4HR	-0.284*** (0.02)	-0.26*** (0.07)	0.28*** (0.09)	-0.11*** (0.02)	0.27* (0.10)	-0.126*** (0.05)
TV5PLUS	-0.38*** (0.02)	-0.42*** (0.08)	0.51*** (0.10)	-0.12*** (0.02)	0.53*** (0.11)	-0.125** (0.06)
TVLIVESPORT	0.14*** (0.01)	0.127*** (0.04)	-0.23*** (0.05)	0.04*** (0.01)	-0.24*** (0.05)	0.05 (0.03)
TVOTHERSPORT	0.15*** (0.01)	0.16*** (0.04)	-0.28*** (0.05)	0.03*** (0.01)	-0.32*** (0.06)	0.022 (0.03)
CONSTANT	1.43*** (0.16)	1.64** (0.65)	-0.64 (0.72)	2.21*** (0.13)	-0.87 (0.79)	2.18*** (0.40)
MONTH DUMMIES	YES	YES	YES		YES	
WEIGHTS	YES	YES	N/A		N/A	
Log-likelihood	-61255.07	-30473.77	-37160.22		-27653.01	
Pseudo R^2	0.09	0.01				
Number of Iterations	2	3	3		4	
N	11632	11632	11645		11645	

Notes: as Table 4.

Figure 4: Hours of Participation (Aggregated)

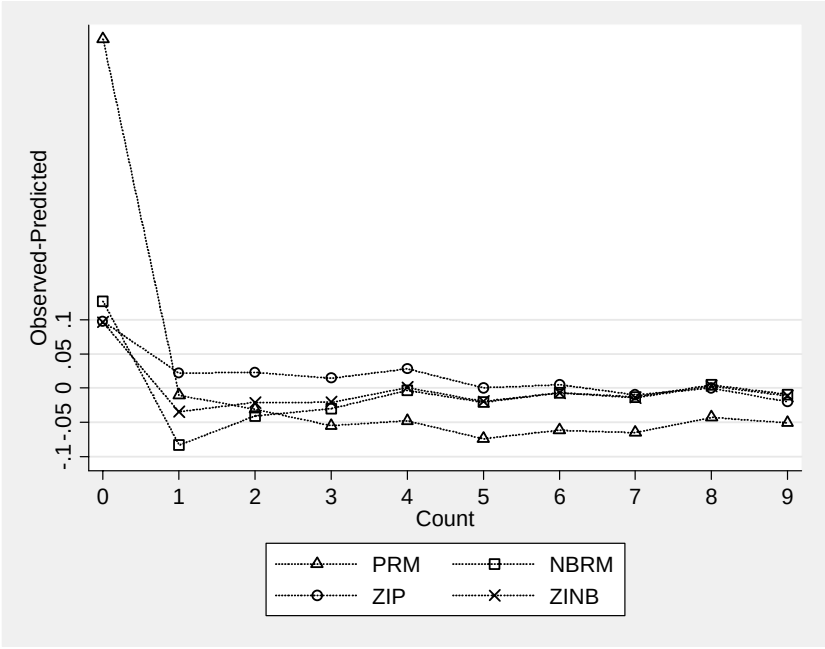

Figure 5: Days of Participation (Aggregated)

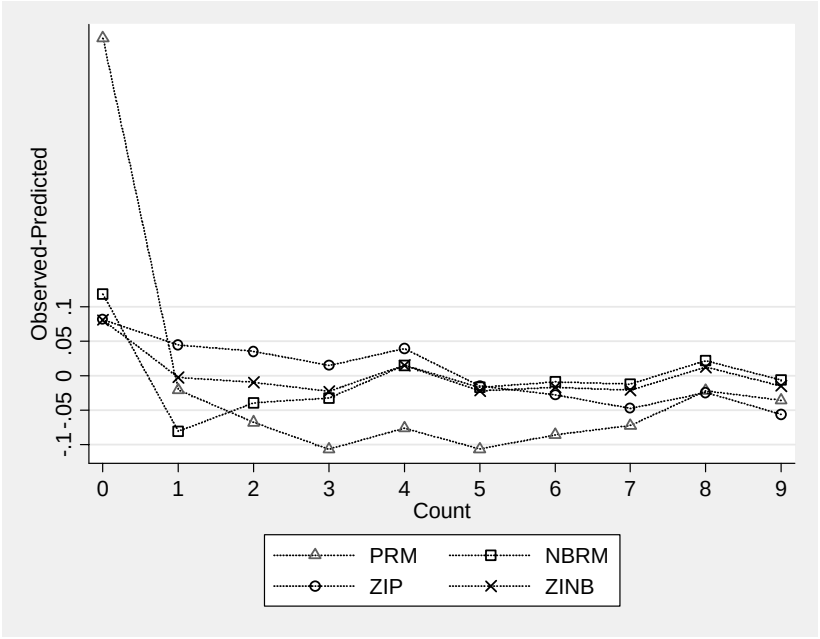

Table 7: Comparison of Count Models – Test Statistics

Hours of Participation				
	Poisson	**Neg Bin**	**ZIP**	**ZINB**
AIC	20.02	5.59	13.12	5.46
BIC	131426.2	-46997.7	46425.4	-48250.96
Likelihood Ratio Test		[a]1.78×10^5		[b]94685.81
Vuong Test			[c]51.70	[d]26.61

Days of Participation				
	Poisson	**Neg Bin**	**ZIP**	**ZINB**
AIC	10.39	4.97	6.40	4.77
BIC	12347.17	50792.86	33752.42	-52757.48
Likelihood Ratio Test		[a]63149.39		[b]19014.43
Vuong Test			[c]55.89	[d]27.74

Notes: [a] Likelihood ratio test of Poisson vs negative binomial
[b] Likelihood ratio test of ZIP vs ZINB.
[c] Non-nesteed Vuong test of Poisson vs ZIP
[d] Non-nested Vuong test of negative binomial vs ZINB.

Table 8: Hours of Participation: Individual Sports

Variable	Swimming (indoors)		Cycling		Health, fitness, gym or conditioning	
	Logit	Neg Bin	Logit	Neg Bin	Logit	Neg Bin
SINGLE	0.22** (0.09)	-0.09** (0.04)	-0.10 (0.57)	0.30 (0.44)	-0.21** (0.09)	0.08** (0.04)
MARRIED	-0.01 (0.08)	-0.15*** (0.03)	-0.88* (0.51)	0.16 (0.32)	-0.08 (0.08)	0.03 (0.03)
ASIAN	0.93*** (0.12)	0.19*** (0.05)	0.60 (0.55)	-0.44 (0.32)	-0.11 (0.10)	-0.01 (0.04)
BLACK	1.08*** (0.15)	0.07 (0.07)	0.50 (0.63)	-0.34 (0.59)	0.16 (0.13)	0.04 (0.05)
OTHERETH	0.342** (0.16)	-0.01 (0.06)	0.81 (1.02)	-0.14 (0.62)	0.09 (0.16)	0.04 (0.07)
WORKING	0.05 (0.11)	-0.06 (0.05)	1.18*** (0.42)	-0.67** (0.26)	-0.15 (0.12)	-0.03 (0.05)
STUDENT	0.10 (0.18)	0.02 (0.07)	1.83 (1.11)	4.31** (1.71)	-0.22 (0.17)	-0.09 (0.07)
KEEPHOUSE	0.08 (0.14)	0.03 (0.06)	0.82 (0.65)	-1.00** (0.48)	0.03 (0.16)	-0.11 (0.07)
RETIRED	0.07 (0.15)	-0.02 (0.06)	0.80 (0.67)	-1.11** (0.43)	-0.05 (0.16)	0.03 (0.07)
ILLNOTWORK	0.30 (0.22)	0.01 (0.1)	0.80 (1.11)	-1.15 (1.03)	0.41 (0.27)	-0.15 (0.12)
HE	-0.31*** (0.06)	-0.14*** (0.02)	0.10 (0.31)	-0.62*** (0.20)	-0.54*** (0.06)	-0.037 (0.026)
ALEVEL	-0.20*** (0.07)	-0.05* (0.03)	-0.002 (0.36)	-0.10 (0.33)	-0.36*** (0.07)	0.04 (0.03)
MALE	0.42*** (0.06)	0.09*** (0.02)	-0.45 (0.29)	0.06 (0.18)	0.24*** (0.06)	0.02 (0.02)
AGE	0.03*** (0.003)	-0.01*** (0.001)	0.026* (0.014)	0.006 (0.010)	0.02*** (0.002)	-0.006*** (0.001)
DRINKDAILY	0.04 (0.09)	-0.15*** (0.04)	1.16 (0.73)	-0.44 (0.77)	-0.007 (0.09)	0.03 (0.04)
SMKDAILY	0.22*** (0.07)	0.117*** (0.03)	0.79* (0.45)	0.38 (0.35)	0.45*** (0.07)	0.002 (0.03)
GENHEALTH	-0.154*** (0.03)	-0.01 (0.01)	-0.35* (0.19)	0.13 (0.17)	-0.20*** (0.03)	0.06*** (0.01)
NADULT	0.13*** (0.03)	0.018 (0.014)	-0.02 (0.17)	-0.16 (0.11)	-0.07** (0.03)	-0.006 (0.013)
NCHILD	-0.15*** (0.03)	0.04*** (0.01)	0.03 (0.14)	0.08 (0.10)	0.08*** (0.03)	-0.01 (0.01)
LOGINCOME	-0.019 (0.013)	-0.008 (0.006)	-0.05 (0.09)	0.36** (0.11)	-0.04*** (0.015)	-0.01* (0.0058)
SPCLOSE	-0.79*** (0.14)	-0.16** (0.06)	-1.20 (1.01)	-0.98 (0.84)	-0.45*** (0.13)	-0.008 (0.006)
VOLUNTARY	-0.22*** (0.05)	0.008 (0.22)	-0.18 (0.28)	0.19 (0.18)	-0.17*** (0.06)	-0.013 (0.02)
LIVESPORT	-0.03 (0.07)	-0.012 (0.03)	-0.08 (0.34)	0.43** (0.21)	-0.23*** (0.07)	0.052* (0.027)
TV1HR	0.22** (0.09)	0.018 (0.04)	-0.74 (0.58)	-0.25 (0.38)	-0.08 (0.10)	-0.025 (0.04)
TV2HR	0.30*** (0.09)	0.03 (0.03)	-0.42 (0.56)	-0.42 (0.40)	0.10 (0.09)	-0.04 (0.04)
TV3HR	0.49*** (0.09)	0.05 (0.04)	0.08 (0.62)	-0.02 (0.40)	0.11 (0.10)	-0.01 (0.04)
TV4HR	0.50*** (0.10)	0.14*** (0.04)	-0.86 (0.60)	-0.38 (0.40)	0.26** (0.11)	-0.001 (0.05)
TV5PLUS	0.70*** (0.12)	0.11** (0.05)	-0.55 (0.68)	-0.71 (0.44)	0.46*** (0.13)	0.04 (0.05)
TVLIVESPORT	-0.11* (0.06)	-0.03 (0.02)	0.11 (0.30)	-0.63** (0.25)	-0.093 (0.06)	0.038 (0.025)
TVOTHERSPORT	0.05 (0.07)	-0.03 (0.03)	-0.06 (0.33)	0.17 (0.22)	-0.10 (0.06)	0.01 (0.03)
CONSTANT	1.21*** (0.31)	4.56*** (0.13)	6.63 (1.86)	1.60 (1.91)	2.79*** (0.32)	4.25*** (0.13)
MONTH DUMMIES	NO		NO		NO	
REGION DUMMIES	YES		YES		YES	
LOG-LIKELIHOOD	-15750.93		-613.39			
VUONG	44.54***		6.74***		39.70***	
N	12360		12370		12356	

Table 8 (cont.)

Variable	Keepfit, aerobics, dance exercise		Football (outdoors)		Jogging	
	Logit	Neg Bin	Logit	Neg Bin	Logit	Neg Bin
SINGLE	0.07 (0.12)	-0.001 (0.06)	0.48*** (0.18)	-0.06 (0.07)	0.02 (0.15)	0.135* (0.08)
MARRIED	-0.03 (0.10)	-0.09* (0.05)	0.45*** (0.17)	-0.17** (0.07)	0.06 (0.14)	0.139** (0.07)
ASIAN	0.04 (0.14)	0.10 (0.07)	0.09 (0.15)	0.02 (0.06)	0.27* (0.16)	-0.05 (0.07)
BLACK	-0.23 (0.15)	-0.07 (0.07)	-0.42** (0.18)	0.18*** (0.06)	-0.13 (0.18)	0.07 (0.08)
OTHERETH	-0.02 (0.20)	-0.22** (0.10)	-0.30 (0.23)	0.13 (0.08)	-0.45** (0.21)	0.01 (0.09)
WORKING	-0.07 (0.15)	0.007 (0.08)	0.27 (0.17)	-0.04 (0.06)	-0.07 (0.18)	-0.02 (0.08)
STUDENT	0.07 (0.24)	-0.010 (0.12)	0.23 (0.22)	-0.10 (0.08)	0.30 (0.25)	0.08 (0.12)
KEEPHOUSE	-0.003 (0.19)	-0.002 (0.09)	-0.05 (0.27)	-0.13 (0.11)	0.39 (0.27)	0.09 (0.13)
RETIRED	-0.23 (0.20)	-0.03 (0.10)	-0.02 (0.45)	0.14 (0.20)	1.08*** (0.35)	0.12 (0.17)
ILLNOTWORK	0.27 (0.33)	-0.33** (0.17)	0.97* (0.50)	0.11 (0.21)	1.13 (0.74)	0.04 (0.38)
HE	-0.21*** (0.08)	0.02 (0.04)	0.05 (0.11)	0.02 (0.04)	-0.55*** (0.10)	-0.08* (0.05)
ALEVEL	-0.17* (0.09)	-0.01 (0.05)	-0.05 (0.11)	-0.01 (0.04)	-0.02 (0.12)	-0.07 (0.06)
MALE	1.32*** (0.09)	-0.03 (0.04)	-2.10*** (0.13)	0.27*** (0.05)	-0.38*** (0.09)	0.10**.04)
AGE	0.02*** (0.004)	-0.003 (0.002)	0.107 (0.01)	-0.009*** (0.003)	0.04*** (0.005)	0.0003 (0.002)
DRINKDAILY	0.004 (0.12)	0.007 (0.06)	0.19 (0.19)	0.03 (0.08)	0.02 (0.15)	-0.10 (0.07)
SMKDAILY	0.30*** (0.10)	0.02 (0.05)	0.09 (0.11)	0.04 (0.04)	0.95*** (0.13)	0.11 (0.07)
GENHEALTH	-0.17*** (0.05)	0.016 (0.02)	-0.16*** (0.06)	0.05** (0.02)	-0.46*** (0.06)	0.06**0.03)
NADULT	0.03 (0.04)	-0.018 (0.02)	-0.04 (0.05)	0.05*** (0.02)	-0.01 (0.05)	-0.05**0.02)
NCHILD	0.072* (0.04)	-0.035* (0.02)	-0.17*** (0.04)	0.01 (0.02)	0.01 (0.04)	0.001 (0.02)
LOGINCOME	-0.01 (0.02)	-0.006 (0.009)	-0.01 (0.02)	0.001 (0.008)	0.01 (0.02)	0.0004 (0.01)
SPCLOSE	-0.27* (0.16)	0.078 (0.08)	-0.108 (0.20)	-0.09 (0.07)	-0.31 (0.21)	-0.12 (0.099)
VOLUNTARY	-0.18** (0.07)	0.09** (0.04)	-0.43 (0.10)	0.04 (0.03)	-0.40*** (0.08)	0.08**0.04)
LIVESPORT	-0.02 (0.10)	-0.004 (0.05)	-0.73*** (0.096)	0.01 (0.03)	-0.30*** (0.09)	0.07 (0.04)
TV1HR	-0.12 (0.14)	-0.03 (0.07)	-0.12 (0.18)	0.02 (0.07)	0.24* (0.14)	-0.07 (0.06)
TV2HR	0.01 (0.13)	-0.05 (0.06)	0.04 (0.17)	-0.05 (0.06)	0.46*** (0.13)	-0.03 (0.06)
TV3HR	0.02 (0.13)	-0.02 (0.06)	0.06 (0.17)	0.01 (0.06)	0.60*** (0.14)	0.01 (0.06)
TV4HR	0.12 (0.15)	-0.02 (0.07)	0.01 (0.19)	0.11 (0.07)	0.87*** (0.17)	-0.01 (0.08)
TV5PLUS	0.44** (0.17)	-0.11 (0.08)	-0.07 (0.21)	-0.03 (0.08)	1.06*** (0.22)	-0.07 (0.10)
TVLIVESPORT	-0.09 (0.08)	-0.04 (0.04)	-1.16*** (0.12)	0.05 (0.05)	-0.52*** (0.10)	0.093**0.05)
TVOTHERSPORT	-0.08 (0.09)	0.06 (0.04)	-0.16* (0.09)	0.02 (0.03)	-0.28*** (0.09)	-0.09**0.04)
CONSTANT	2.33*** (0.41)	4.14*** (0.20)	1.703*** (0.53)	4.22*** (0.20)		3.56***(0..24)
MONTH DUMMIES	NO		NO		NO	
REGION DUMMIES	YES		YES		YES	
LOG-LIKELIHOOD	-8302.01		-5911.58		-5984.26	
VUONG	25.96***		25.88		23.55	
N	12360		12349		12367	

Table 8 (cont.)

Variable	Golf, pitch and putt, putting	
	Logit	**Neg Bin**
SINGLE	0.10 (0.23)	0.13 (0.11)
MARRIED	-0.43** (0.20)	0.12 (0.10)
ASIAN	0.79*** (0.30)	0.16 (0.15)
BLACK	1.63*** (0.59)	-0.68** (0.29)
OTHERETH	0.39 (0.43)	-0.004 (0.21)
WORKING	-0.11 (0.30)	-0.05 (0.15)
STUDENT	-0.50 (0.41)	-0.12 (0.21)
KEEPHOUSE	-0.36 (0.46)	0.06 (0.23)
RETIRED	-0.78** (0.35)	-0.05 (0.17)
ILLNOTWORK	-0.21 (0.55)	-0.20 (0.27)
HE	-0.33 (0.13)	0.03 (0.07)
ALEVEL	-0.11 (0.16)	-0.10 (0.08)
MALE	-1.12*** (0.14)	0.17** (0.07)
AGE	0.02*** (0.006)	0.0055* (0.003)
DRINKDAILY	-0.19 (0.17)	0.09 (0.08)
SMKDAILY	0.17 (0.15)	-0.04 (0.08)
GENHEALTH	-0.25 (0.08)	0.046 (0.04)
NADULT	-0.06 (0.07)	-0.08** (0.04)
NCHILD	0.25 (0.08)	-0.06 (0.04)
LOGINCOME	-0.02 (0.03)	0.003 (0.02)
SPCLOSE	-0.74 (0.37)	-0.003 (0.18)
VOLUNTARY	0.034 (0.13)	0.03 (0.06)
LIVESPORT	-0.13 (0.13)	0.04 (0.06)
TV1HR	-0.017 (0.24)	-0.02 (0.12)
TV2HR	-0.04 (0.22)	-0.004 (0.10)
TV3HR	0.15 (0.23)	0.03 (0.11)
TV4HR	0.20 (0.25)	-0.02 (0.12)
TV5PLUS	0.59* (0.31)	0.15 (0.15)
TVLIVESPORT	-0.79*** (0.15)	0.07 (0.07)
TVOTHERSPORT	-0.39*** (0.12)	0.02 (0.06)
CONSTANT	6.74*** (0.79)	4.24*** (0.38)
MONTH DUMMIES	NO	
REGION DUMMIES	YES	
LOG-LIKELIHOOD	-3397.91	
VUONG	10.71***	
N	11997	